
TEXAS A&M UNIVERSITY-KINGSVILLE

Department of Mechanical and Industrial Engineering

Term: FALL 2017

Course Number: MEEN 5335

Title: ADVANCED ROBOTICS AND AUTOMATION

Credit Hours: 3

Class Period: TR 12:30pm-1:45pm

Instructor: Dr. Selahattin Ozcelik

Engineering Complex. Room 325

Phone: 593-2291, E-mail: sozcelik@tamuk.edu

Office Hours: TR:11:00am-12:30pm, W:11:00am-1:00pm

2015-2017 Catalog Description:

MEEN 5335: Advanced Robotics and Automation

Analysis of methods of design and operation of robots and robotic systems. Kinematics and dynamics of manipulators, trajectory planning and motion control, sensing and vision, discussion of command languages and planning of job assignments.

Text Book:

- R. Siegwart, I. Nourbakhsh, Introduction to Autonomous Mobile Robots, MIT Press, 2nd ed. 2011.
- Peter Corke, Robotics, Vision and Control: Fundamental Algorithms in MATLAB 1st ed. 2011

References:

- R. Kelly, Control of Robot Manipulators in Joint Space, Springer-Verlag, 2006.
- Angeles, J., Fundamentals of Robotic Mechanical Systems, Springer-Verlag, New York, NY, 1997.
- Craig, J.J., Introduction to Robotics: Mechanics and Control, 3rd Edition, Addison-Wesley, Reading, MA, 2004.
- Siciliano, B., Sciavicco, L., Villani, L., Oriolo, G., Robotics: Modelling, Planning and Control, Springer 2009.
- Howie Choset, Kevin Lynch, Seth Hutchinson, Principles of Robot Motion: Theory, Algorithms, and implementations., MIT Press, 2005.

Software:

MATLAB\SIMULINK

Grading Policy, Exams, Homework, etc.:

- Exam I 150 pts.
- Exam II 150 pts.
- Assignments 125 pts.
- Attendance/Participation 75 pts.

Guidelines:

Policies for attendance, excused absences, make-up exams, late assignments, early final exams, cell phones, etc: Successful performance in this class requires that you attend class. Make-ups for missed exams are granted only for excused (official university) absences. Please note that attendance policies may vary by college). No late assignments will be accepted. Students should turn off their cell phones during class. Students will work on a design project that will cover the modeling, analysis, and design of a given system.

Course Objective:

The objective of this course is to give the students the basic principles, design, analysis, and synthesis of robotic systems.

Course Contents:

- Robotic Manipulators:

- Robot Arm Kinematics: Coordinate frames, rotations, homogeneous coordinates, link coordinates, the direct kinematics problem, the inverse kinematics solution
- Robot Arm Dynamics: Lagrange's equation, kinetic and potential energy, Lagrange-Euler formulation, Newton-Euler formulation, generalized D'Alembert equations of motion
- Differential Motion and Statics: The tool-configuration jacobian matrix, joint-space singularities, the manipulator jacobian, induced joint torques and forces
- Trajectory Planning: Robot workspace analysis, joint-interpolated trajectories, planning of manipulator cartesian path trajectories

Mobile Robots:

- Mobile Robot Hardware: Locomotion, Offboard communication, Processing.
- Reasoning: Representing Space, Path planning for mobile robots, Planning for multiple robots
- Operating Environment: Functional Decomposition, Algorithms
- Pose Maintenance
- Maps and related tasks
- Practical Mobile Robot tasks

Sensing and Actuating:

- Actuating Systems
- Nonvisual Sensors and Algorithms
- Visual Sensors and Algorithms:

Control Algorithms:

- Basic control algorithms
- Intelligent control architectures
- Robot Programming Languages

Mission Statement:

The mission of the faculty of the Advanced Robotics and Automation class is to give students the principles, design, analysis, and synthesis of robotic systems.

Course Objectives:

The objectives of the Advanced Robotics and Automation class are to help students learn:

1. Coordinate frames, rotations, transformations, link coordinates, direct kinematics and inverse kinematics;
2. How to apply Lagrange's equation, kinetic and potential energy, Lagrange-Euler formulation, Newton-Euler formulation, generalized D'Alembert equations for deriving the equations of motion for a given robot;
3. Jacobian matrix, joint-space singularities, the manipulator jacobian, and induced joint torques and forces;
4. Robot workspace analysis, joint-interpolated trajectories, and trajectory planning of a robot;
5. State equations of a robot, linear feedback systems, PD control, and single-axis PID control;
6. Range sensing, Proximity sensing, touch sensors, force and torque sensing;
7. Characteristics of robot-level languages, characteristics of task-level languages

Course Outcomes:

At the completion of this Advanced Robotics and Automation class, students should be able to:

1. establish coordinate frames and perform homogeneous transformations for a given robot;
2. obtain the solution to direct and inverse kinematics problems for a given robot;
3. derive equations of motion using Lagrange-Euler and/or, Newton-Euler formulation of robot;
4. derive Jacobian matrix, singularities, and induced joint torques and forces of a robot;
5. plan a trajectory for given specifications and convert it to joint-interpolated trajectories;
6. manipulate block diagrams and calculate important transfer functions;
7. design suitable and simple control system for required task of a robot;
8. learn about sensors currently used in robotics and its applications;
9. familiar with robot programming languages;

Disability statement (See pages 2 & 11 of Student Handbook):

Students with disabilities, including learning disabilities, who wish to request accommodations in class should register with the Services for Students with Disabilities (SSD) early in the semester so that appropriate arrangements may be made. In accordance with federal laws, a student requesting special accommodations must provide documentation of their disability to the SSD coordinator.

Academic misconduct (See page 23, section 100 of Student Handbook):

You are expected to practice academic honesty in every aspect of this course and all other courses. Make sure you are familiar with your Student Handbook, especially the section on academic misconduct. Students who engage in academic misconduct are subject to university disciplinary procedures.

Forms of academic dishonesty:

1. Cheating: deception in which a student misrepresents that he/she has mastered information on an academic exercise that he/she has not mastered; giving or receiving aid unauthorized by the instructor on assignments or examinations.
2. Academic misconduct: tampering with grades or taking part in obtaining or distributing any part of a scheduled test.
3. Fabrication: use of invented information or falsified research.
4. Plagiarism: unacknowledged quotation and/or paraphrase of someone else's words, ideas, or data as one's own in work submitted for credit. Failure to identify information or essays from the Internet and submitting them as one's own work also constitutes plagiarism.

Non-academic misconduct (See page 23, section 100 of the Student Handbook):

The university respects the rights of instructors to teach and students to learn. Maintenance of these rights requires campus conditions that do not impede their exercise. Campus behavior that interferes with either (1) the instructor's ability to conduct the class, (2) the inability of other students to profit from the instructional program, or (3) campus behavior that interferes with the rights of others will not be tolerated. An individual engaging in such disruptive behavior may be subject to disciplinary action. Such incidents will be adjudicated by the Dean of Students under non-academic procedures.

Sexual misconduct (See page 23, section 200 of Student Handbook):

Sexual harassment of students and employers at Texas A&M University-Kingsville is unacceptable and will not be tolerated. Any member of the university community violating this policy will be subject to disciplinary action.